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Nitrogen management for optimum productivity of dry direct seeded rice (*Oryza sativa*, L.) under medium deep black soils

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Abstract: Field experiment was conducted at Agricultural Research Station, Gangavathi, Karnataka during the rainy season of 2013 and 2014 to study the effect of two nitrogen levels,*viz.,* 120:60:50 and 150:60:50 kg, N, P_2O_5 and K_2O/ha and four splits and application timings on the performance of dry direct seeded rice. The data revealed that application of 150:60:50 kg N,P_2O_5 & K_2O/ha with full P and K applied as basal and nitrogen in three equal splits at sowing, active tillering and panicle initiation recorded significantly higher grain yield (46.62 q/ha) than other treatment combinations and resulted in higher net returns (₹ 43495/ha) and benefit-cost ratio (2.09). Improved yield parameters like higher number of panicles per square meter and higher panicle weight have contributed for higher grain yield in the above treatments.

Key words : Direct seeded rice, Nitrogen, Panicle, Spikelets

Introduction

Rice is an important food crop of India grown over an area of 43.5 million hectare with a production of 105.5 million tons and productivity of 2.4t/ha (Anon., 2016). It is also an important crop of Karnataka growing over an area of 14.16 lakh ha with a production of 39.55 lakh tons. Due to dwindling water resources throughout the world water has become a scarce resource for rice production. Taking advantages of saving in water and labour and increasing system productivity dry direct seeded rice(DSR) has been believed to be optimal option for rice productivity (Kumar and Ladha, 2011). In recent years the area under dry direct seeding in Tungabadra command of Karnataka state is increasing. Dry direct seeded rice has many advantages including lower cost of land preparation, lower water requirement and savings in seed and labour and elimination of nursery raising and transplanting. Nitrogen is the most important nutrient required in relatively large amounts and at different stages of crop growth. It is primarily responsible for biomass production and determining important yield attributes like panicle and spikelet number and spikelet weight depending upon the time of application and these attributes in turn determine the grain yield. Therefore application of right amount of N matching the requirement of different stages of rice is very important in increasing the yield in dry DSR. Lot of research work is done on N management in transplanted rice. However, such information in dry direct seeded rice is scanty. In the present investigation the effect of different doses, splits and time of application of nitrogen on growth and yield of dry DSR is taken up.

Material and methods

Field experiment was conducted during the rainy season of 2013 and 2014 at the Agricultural Research Station, Gangavati, Karnataka. The soil of the experimental site was medium deep black clay in texture, neutral to alkaline in reaction (pH 8.3 to 8.5) and low in electrical conductivity (0.30 to 0.60dS/m). The soil was low in alkaline $KMnO_4$-N (235 kg ha^{-1}), medium in Olsen's-P_2O_5(37.8 kg ha^{-1}) and high in NH_4OAc extractable K_2O (485 kg ha^{-1}) in the surface 0-20cm depth. The treatments consisted of two NPK levels *viz.,* M_1:120:60:50 and M_2:150:60:50 kg N, P_2O_5 and K_2O/ha and six schedules of application *viz.,* S_1: N-2splits (1/2 basal +1/2 panicle initiation (PI) S_2: N-2splits (1/2 12 days after emergence(DAE)+1/2 PI), S_3: N -3 splits(1/3 basal+1/3 active tillering(AT) +1/3 PI, S_4: N -3 splits(1/3 12DAE+1/3 AT +1/3 PI, S_5: N -4 splits(1/4 basal+1/4 AT +1/4 PI+1/4 flowering(fl), S_6 : N -4 splits(1/4 12 DAE+1/4 AT +1/4 PI+1/4 fl, were tried in split-plot design. Seeds of rice, c.v.GGV-05-01(Gangavathi sona) were hand sown @ 35 kg/ha in rows spaced at 25 cm on 8th August and 12th August during 2013 and 2014 respectively followed by irrigation. Two days after irrigation pendimethalin 30EC @1.0 kg.a.i/ha was sprayed on soil @500l/ha. One hand weeding was given 50 days after sowing. Fertilizers were applied as per the treatments. The crop was sprayed with 0.5% ferrous sulphate twice at 15 and 20 days after sowing to control iron deficiency. Alternate wetting and drying method of irrigation was followed. Observations on grain yield and yield parameters were recorded and the collected data were subjected to statistical analysis as described by Gomez and Gomez (1984) and the economics of N application was worked.

Results and discussion

Effect on grain yield

Application of 150:60:50 kg N,P_2O_5 & K-$_2$O/ha recorded significantly higher rice grain yield of 40.45 and 45.48q/ha during 2013 and 2014 respectively than 120:60:50 kg N,P_2O_5 & K_2O/ha (control) with grain yields of 34.80 and 41.06 q/ha respectively during 2013 and 2014. The treatment recorded a mean grain yield of 42.99 q/ha over control (37.92q/ha) representing 11.8% higher yield. Nitrogen is the most important nutrient required for yield formation and in the present study the higher grain yield is attributed to increased dose of nitrogen. Pathak *et al.* (2011) reported higher grain yield of dry direct seeded rice at an NPK dose of 120-150kgN,60 kg P_2O_5 & 40 Kg K_2O/ha along with 25 kg ZnSO4/ha. While, Sathiya *et al.* (2008), Ramesh *et al.* (2009) and Mahajan *et al.* (2012) reported higher grain yield of aerobic rice with application of N at an higher range of 140 -175 kg/ha.

Among different N scheduling, application of N in three equal splits with 1/3each at sowing, active tillering and panicle initiation recorded significantly higher grain yield of 42.11 and 46.96q/ha during 2013 and 2014 respectively than other schedule of application. The treatment recorded a mean grain yield of 44.53q/ha which was significantly superior to any other scheduling of N. The interaction effect of doses of N and splits and timings of application was significant. Application of 150:60:50 kg N, P_2O_5 & K-$_2$O/ha in three equal split doses at sowing, active tillering and panicle initiation recorded significantly higher grain yield than other schedules during both years and in the mean data. Earlier,Yong *et al.* (2009) reported that application of 220 kg N in five splits recorded higher grain yield. Kamboj *et al.* (2012) reported that split application of nitrogen 1/3each at sowing, active tillering and panicle initiation recorded higher grain yield in direct seeded rice. Where as Hafeez Ur Rehman *et al.* (2013) reported better yields with 140 kg N applied at sowing and anthesis. Similarly, D. K. Singh *et al.* (2015) reported that application of 150 kg N in four equal splits at sowing, active tillering, panicle initiation and flowering recorded higher grain yield in direct seeded rice. Between the nitrogen doses the number of panicles per square meter were significantly higher in the case of 150:60:50 kg N, P_2O_5 and K_2O/ha than 120:60:60 kg N, P_2O_5 &K_2O/ha during 2013. Among different N scheduling application of 1/3 each of N at basal, active tillering and panicle initiation recorded significantly more number of panicles than other scheduling during both 2013 and 2014. Among the treatment combinations application of 150:60:50 kg N, P_2O_5 and K_2O/ha and with N in three equal splits at basal, active tillering & panicle initiation (478.7 no/sqm) recorded significantly more number of panicles than other combinations. Time of application and applying in spilt doses coinciding correct physiological stage is important in realizing optimum yield in dry DSR. In the present study split application of nitrogen at active tillering promoted the tiller number which is evidenced by higher number of panicles per unit area. The increased number of panicles inturn contributed for higher grain yield in the above treatment. Hongyan *et al.* (2014) reported that the grain yield of dry direct seeded rice is mainly controlled by the panicle number.

Panicle weight did not differ significantly between N doses. Among different N scheduling application of 1/3 each of N at basal, active tillering and panicle initiation recorded significantly higher panicle weight than other schedule during both years. The interaction revealed that the treatment combination of

Table.1 Effect of nitrogen levels and time of application on grain yield and its parameters in direct seeded rice

Treatments	Panicles/sq.m. (no)		Panicle weight (g)		Grain yield (q/ha)		
Level of N, P_2O_5 and K_2O (kg/ha)	2013	2014	2013	2014	2013	2014	Mean
N_1:120:60:50	370	337	2.19	2.70	34.80	41.06	37.92
N_2:150:60:50	414	360	2.16	3.29	40.45	45.48	42.99
S.Em±	10.6	6.9	0.11	0.1	0.82	0.87	0.42
C.D. (5%)	33.9	NS	NS	NS	2.54	2.87	1.38
Splits & time of application							
T_1	372	345	2.01	2.82	36.05	40.96	38.51
T_2	424	329	2.19	2.56	37.77	43.72	40.75
T_3	436	403	2.42	3.37	42.11	46.96	44.53
T_4	394	348	1.85	3.22	35.94	42.00	39.05
T_5	362	343	2.20	3.00	37.02	42.81	39.91
T_6	365	322	2.40	3.00	36.84	43.17	40.00
S.Em±	12.4	6.7	0.09	0.10	0.87	0.67	0.65
C.D. (5%)	36.5	19.7	0.27	0.30	2.56	1.96	1.91
Interaction							
N_1T_1	343	336	1.80	2.44	32.14	37.39	33.73
N_1T_2	398	326	2.48	1.96	33.87	42.91	38.25
N_1T_3	394	384	2.36	3.17	39.51	44.88	42.45
N_1T_4	390	321	1.85	3.22	34.59	38.72	36.99
N_1T_5	337	326	2.18	2.70	33.99	40.16	37.81
N_1T_6	361	330	2.41	2.74	31.63	42.30	38.36
N_2T_1	402	354	2.23	3.20	39.56	44.53	43.31
N_2T_2	449	332	1.82	3.17	38.75	44.54	43.25
N_2T_3	479	423	2.56	3.58	40.71	49.05	46.62
N_2T_4	398	376	1.85	3.22	35.64	45.28	41.11
N_2T_5	387	359	2.22	3.29	40.47	45.45	42.02
N_2T_6	368	315	2.40	3.25	38.97	44.03	41.65
S.Em±	16.9	11.1	0.16	0.16	1.20	0.98	0.87
C.D. (P=0.05)	49.8	32.7	0.47	0.48	3.53	2.88	2.56

Table 2. Effect of nitrogen levels and time of application on the net returns and benefit-cost ratio (BCR) in direct seeded rice

Treatments	Net returns(₹/ha)			BCR		
Level of N,P_2O_5 and K_2O (kg/ha)	2013	2014	Mean	2013	2014	Mean
N_1:120:60:50	23530	33556	28543	1.60	1.85	1.72
N_2:150:60:50	33180	41264	37222	1.84	2.04	1.94
S.Em±	938.4	1250	605	0.02	0.03	0.01
C.D. (5%)	5709	7610	1857	0.14	NS	0.04
Splits & time of application						
T_1	25766	33568	29667	1.65	1.86	1.76
T_2	29335	38431	33883	1.75	1.98	1.86
T_3	35951	43687	39820	1.91	2.10	2.00
T_4	25470	35453	30462	1.64	1.90	1.77
T_5	27189	36248	31718	1.68	1.91	1.79
T_6	26418	37072	31745	1.66	1.93	1.79
S.Em±	1503	1535	1099	0.04	0.04	0.03
C.D. (5%)	4433	4528	3242	0.11	0.11	0.08
Interaction						
N_1T_1	15303	27438	21371	1.39	1.70	1.55
N_1T_2	22256	36838	29548	1.57	1.94	1.76
N_1T_3	32437	39849	36143	1.83	2.01	1.92
N_1T_4	24433	29502	26967	1.62	1.75	1.68
N_1T_5	24366	31758	28062	1.62	1.80	1.71
N_1T_6	22382	35948	29165	1.56	1.90	1.73
N_2T_1	36228	39698	37963	1.92	2.01	1.96
N_2T_2	36414	40025	38219	1.92	2.02	1.97
N_2T_3	39465	47526	43495	1.99	2.20	2.09
N_2T_4	26508	41405	33956	1.67	2.04	1.86
N_2T_5	30012	40737	35374	1.75	2.02	1.88
N_2T_6	30454	38197	34325	1.76	1.95	1.86
S.Em±	2155	2343	1451	0.05	0.06	0.04
C.D. (P=0.05)	6357	6912	4281	0.16	0.17	0.12

150:60:50 kg N, P_2O_5 and K_2O/ha with N applied in three equal splits at basal, active tillering and panicle initiation recorded higher panicle weight than other combinations. Application of N at panicle initiation is found to have effect on spikelet number and panicle weight. In the present study the panicle weight was higher when N was applied in three stage including panicle initiation which had contributed to higher grain yield in the above treatment.

Economics

The economics revealed that the mean net returns were higher with 150:60:50 kg N,P_2O_5 & K-$_2$O/ha(₹ 37222/ha) than 120:60:50 kg N, P_2O_5 and K-$_2$O/ha(₹ 28543/ha). Similarly, application of N in three equal doses at sowing, active tillering and panicle initiation recorded significantly higher net returns. Among the treatment combinations application of 150:60:50 kg N, P_2O_5 and K_2O/ha in three equal split doses at sowing, active tillering and panicle initiation recorded significantly higher mean net returns of ₹ 43495/ha than other combinations. Benefit cost ratio followed similar trend as that of net returns and the treatment combination of 150:60:50 kg N, P_2O_5 and K_2O/ha and N in three equal splits at sowing, active tillering and panicle initiation recorded higher mean benefit cost ratio of 2.09.

Conclusions

From the two year data on nitrogen management in dry direct seeded rice it was concluded that a fertilizer dose of 150:60:50 kg N, P_2O_5 and K_2O/ha with full P and K applied as basal and nitrogen in three equal splits at sowing, active tillering and panicle initiation found to be optimum in increasing the grain yield and net returns in irrigated black soils of Tungabadra command area.

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